ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS)

A NASA Earth Venture Suborbital Mission

Jens Redemann (Principal Investigator, jens.redemann-1@nasa.gov)[1], Robert Wood[2],
Bernadette Luna (Project Manager, bernadette.luna@nasa.gov)[1], Kent Shiffer[1]

[1]*Earth Science Division, NASA Ames Research Center, Moffett Field, CA, 94035-0001*
[2]*Atmospheric Sciences, Box 351640, University of Washington, Seattle, WA 98195*

Scientific Background

The South East Atlantic is home to one of the three permanent subtropical stratocumulus cloud decks in the world. This cloud deck plays a key role in the energetic balance of the region and is highly important to the global climate system. In the Southern hemisphere spring (July-October), the stratocumulus deck interacts with dense layers of African biomass burning (BB) aerosols. The aerosols originate as smoke particles from central African fires, and initially overlay the cloud deck. They are carried westward and eventually become mixed into the clouds, changing the clouds' structure, composition and microphysical properties, and affecting thermal balance, regional weather, and precipitation. Depending on the relative locations of the aerosols and the cloud deck, clouds may thicken, they may burn-off, or their lifetime may be influenced by aerosol-induced changes in cloud microphysics. The physical processes that govern the interactions between the clouds and the BB aerosols are poorly represented in regional and global models. Airborne observations can separate the effects of clouds and aerosols on the radiation balance, because the airborne instruments can be located within the atmospheric column, because co-varying meteorological conditions can be measured simultaneously, and because the airborne measurements can provide meaningful constraints on the modeling of these processes.

ORACLES key features

- Airborne and ground-based observations of radiation, aerosol & cloud microphysics from above & below aerosol and clouds over the SE Atlantic, coordinated with the British CLARIFY project
- 3 campaigns with profiling P-3 aircraft (Aug.-Sep. 2016, Aug. 2017 & Sept-Oct. 2018)
- 1 campaign with high-altitude ER-2 aircraft (Aug-Sep. 2016)
- Potentially useful for southwest African studies of near-coast ocean ecosystem productivity, surface characteristics of the hyper-arid regions, and the terrestrial coastal fog system
- New ground-sites for AERONET aerosol measurements (St. Helena & Angola)
- Desired operations base: Walvis Bay, Namibia

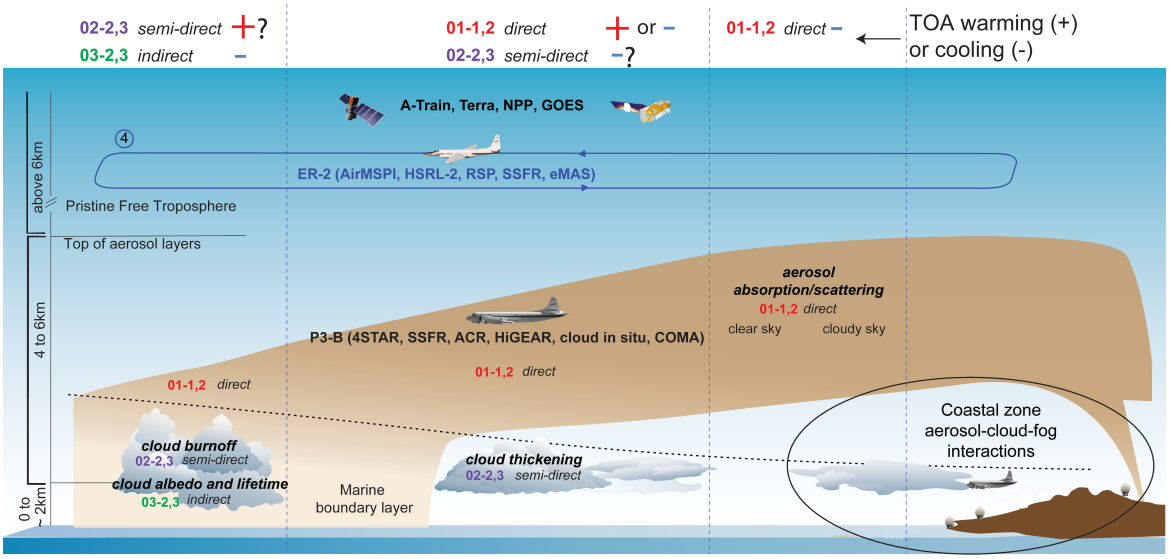

Figure 1: ORACLES scientific objectives and aerosol effects on climate.

ORACLES science objectives

The overall scientific goal of ORACLES is **to understand the processes that control the radiation balance and cloud properties over the South East Atlantic, which impact the regional and global distribution of surface temperatures and precipitation**. The specific scientific goals of the ORACLES mission are:

1) Determine the impact of African BB (Biomass Burning) aerosol on cloud properties and the radiation balance over the South Atlantic.
2) Acquire a process-level understanding of aerosol-radiation interactions and resulting cloud adjustments, and aerosol-cloud interactions, that can be applied globally.
3) Substantiate future measurements by gathering testbed datasets that can be used to verify and refine current and future observation methods and simulation techniques.

ORACLES airborne science platforms

The ORACLES Mission will utilize the NASA P-3 aircraft as a low-flying platform for in-situ and remote sensing measurements of aerosols and clouds in all three years of the campaign. The NASA ER-2 will also be utilized in the first deployment year with a combination of polarimeter, radar and lidar measurements, providing a high altitude view of the science data set.

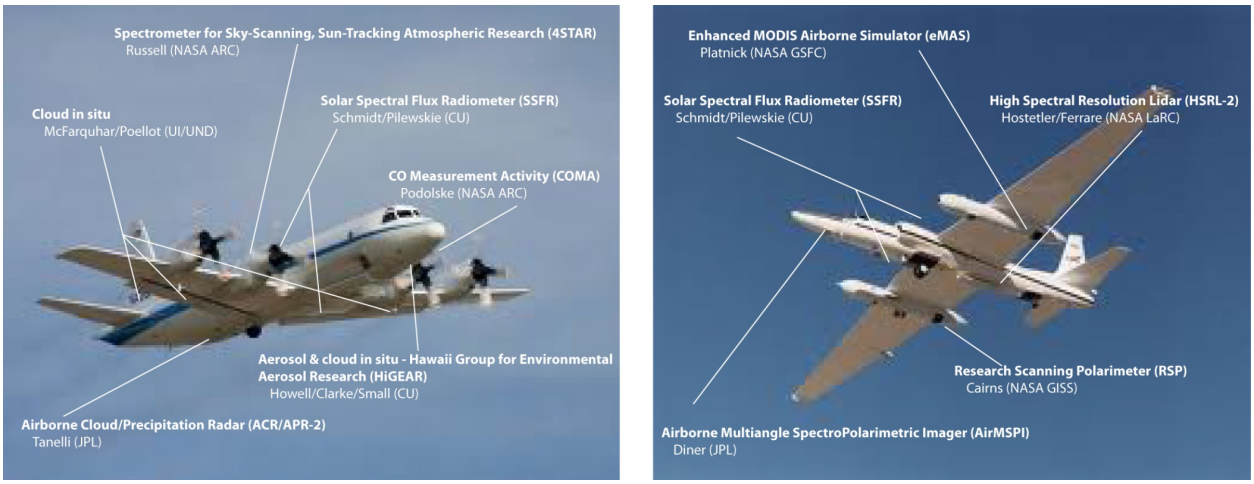

Figure 2: Left - The NASA P-3 will fly the 4STAR, SSFR, HiGEAR, radar, and in-situ cloud measurement systems. Right - The NASA ER-2 will fly the AirMSPI, HSRL-2, RSP, eMAS, and SSFR instruments.

Potential ORACLES benefits to southwestern Africa

The ORACLES mission promises the delivery of knowledge products with both short-term and long-term benefits for the people of southwestern Africa. ORACLES will build scientific capacity, by strengthening and focusing NASA's existing connections to the regional earth science community. In addition, ORACLES scientists will seek new, funded collaborations with their colleagues in Angola, Namibia, Botswana and S. Africa to complement the baseline project. ORACLES observations can be used to study near-coast ocean ecosystem productivity, surface characteristics of the hyper-arid regions, and the link between coastal stratocumulus clouds and in-land fog distributions. Collaborative ground observations will link aerosol source and receptor regions to the coastal and southeast Atlantic airborne campaigns. Most importantly, ORACLES in collaboration with regional scientists will provide a research framework for capacity building – by reaching out to university faculty and students, and facilitating interaction with the project team members.